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ACOP

Doc.Type: **Report**			DRD N°: ENG 18
Doc. N°: **ACP-RP-CGS-002**	Issue: **1**	Date: **Jan. 2005**	Page **1** Of **29**
Title : **Operational Analysis Report**			

	Name & Function	Signature	Date
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CHANGE RECORD			
ISSUE	*DATE*	*CHANGE AUTHORITY*	*REASON FOR CHANGE AND AFFECTED SECTIONS*
1	Jan.05		First Edition

LIST OF VALID PAGES									
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1. SCOPE AND INTRODUCTION

1.1 PURPOSE OF THE DOCUMENT

The purpose of this document is to provide documentation and data for flight operation and maintenance of the AMS-02 Crew Operations Post (ACOP). The ACOP System is intended to fly on the International Space Station (ISS) as a payload installed into a ISPR on the NASA laboratory. The main objective of ACOP is to provide an ISS Internal Facility capable of supporting AMS-02 experiment, performing the recording of Science data. In particular, ACOP shall allow a more flexible and efficient use of ISS TM downlink, providing a temporary backup of data generated by AMS-02 and preventing, in this way, possible losses of valuable data. In addition, ACOP is the operational interface to on board crew in order to control and monitor AMS-02 inside from ISS and to permit files and SW upload into the supported payloads.
ACOP system shall be installed in the U.S. Laboratory Module, on the ISS, in one EXPRESS rack (see, for reference,Fig.1-1 US-LAB).

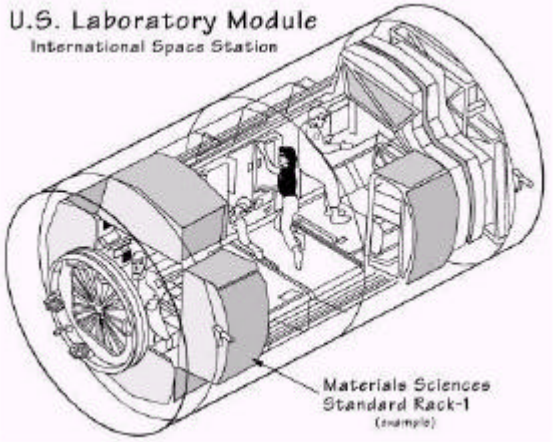

Fig.1-1 US-LAB

The standard configuration of an EXPRESS Rack is commonly known as 8/2. This means that it can accommodate eight ISS locker/Middeck Locker (MDL) and two International Subrack Interface Standard (ISIS), as shown n Fig.1-2.
On-Board Spare parts shall be accommodated in a standard soft bag.

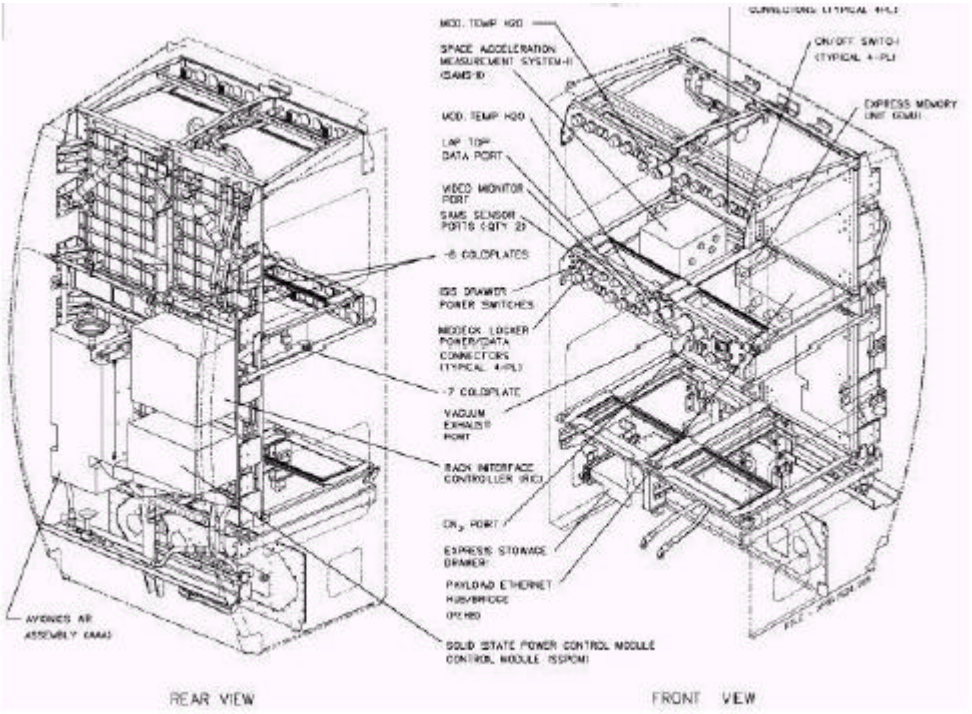

Fig.1-2 Example of Express Rack

1.2 DEFINITIONS AND ACRONYMS

A

AAA	Avionics Air Assembly
ABCL	As-Built Configuration data List
ACOP	AMS-02 Crew Operation Post
ACOP-SW	ACOP Flight Software
ADP	Acceptance Data Package
AMS-02	Alpha Magnetic Spectrometer 02
APS	Automatic Payload Switch
AR	Acceptance Review
ASI	Agenzia Spaziale Italiana *(Italian Space Agency)*
ATP	Authorization To Proceed

B

BC	Bus Coupler
BDC	Baseline Data Collection
BDCM	Baseline Data Collection Model

C

CAD	Computer Aided Design
CCB	Configuration Control Board
CCSDS	Consultative Committee on Space Data Standards (standard format for data transmission)
C&DH	Command & Data Handling
CDR	Critical Design Review
CGS	Carlo Gavazzi Space
CI	Configuration Item
CIDL	Configuration Item data List
CM	Configuration Management
COTS	Commercial Off The Shelf
cPCI	CompactPCI (Euro Card sized standard interface to the PCI)
CSCI	Computer Software Configuration Item
CSIST	Chung Shan Institute of Science and Technology

D

DCL	Declared Components List
DIL	Deliverable Items List
DIO	Digital Input / Output
DML	Declared Materials List
DMPL	Declared Mechanical Parts List
DPL	Declared Processes List
DRB	Delivery Review Board
DRD	Document Requirements Description

E

EEE	Electrical, Electronic & Electromechanical
EGSE	Electrical Ground Support Equipment
EM	Engineering Model
ER	EXPRESS Rack
ERL	EXPRESS Rack Laptop
ERLC	EXPRESS Rack Laptop Computer
ERLS	EXPRESS Rack Laptop Software
EMC	Electro-Magnetic Compatibility
ESA	European Space Agency
EXPRESS	EXpedite the PRocessing of Experiments to Space Station

F

FEM	Finite Element Model
FFMAR	Final Flight Model Acceptance Review
FLASH	Rewriteable persistent computer memory
FM	Flight Model
FMECA	Failure Modes, Effects & Criticalities Analysis
FPGA	Field Programmable Gate Array
FSM	Flight Spare Model

G

GIDEP	Government Industry Data Exchange Program
GSE	Ground Support Equipment

H

HCOR	HRDL Communications Outage Recorder
HD	Hard Drive
HDD	Hard Disk Drive
HRDL	High Rate Data Link
HRFM	High Rate Frame Multiplexer
HW	Hardware

I

ICD	Interface Control Document
I/F	Interface
IRD	Interface Requirements Document
ISPR	International Space-station Payload Rack
ISS	International Space Station

J

JSC	Johnson Space Center

K

KIP	Key Inspection Point
KSC	Kennedy Space Center
KU-Band	High rate space to ground radio link

L

LAN	Local Area Network
LCD	Liquid Crystal Display
LFM	Low Fidelity Model
LRDL	Low Rate Data Link

M

MDL	Mid-Deck Locker
MGSE	Mechanical Ground Support Equipment
MIP	Mandatory Inspection Point
MMI	Man Machine Interface
MPLM	Multi-Purpose Logistic Module
MRDL	Medium Rate Data Link

N

NA	Not Applicable
NASA	National Aeronautics and Space Administration
NCR	Non Conformance Report
NDI	Non Destructive Inspection
NRB	Non-conformance Review Board
NSTS	National Space Transportation System (Shuttle)

O

OLED	Organic Light-Emitting Diode
ORU	Orbital Replacement Unit

P

PA	Product Assurance
PCB	Printed Circuit Board
PCI	Peripheral Component Interconnect (personal computer bus)
PCS	Personal Computer System
PDR	Preliminary Design Review
PEHB	Payload Ethernet Hub Bridge
PEHG	Payload Ethernet Hub Gateway
PFMAR	Preliminary Flight Model Acceptance Review
PLMDM	Payload Multiplexer De-Multiplexer
PMC	PCI (Peripheral Component Interconnect) Mezzanine Card
PMP	Parts, Materials & Processes
PROM	Programmable Read Only Memory
PS	Power Supply

Q

QM	Qualification Model

R

RFA	Request For Approval
RFD	Request For Deviation
RFW	Request For Waiver
RIC	Rack Interface Controller
ROD	Review Of Design
ROM	Read Only Memory
RX	Reception

S

SATA	Serial Advanced Transfer Architecture (disk interface)
S-Band	Space to ground radio link
SBC	Single Board Computer
SC MDM	Station Control Multiplexer De-Multiplexer
ScS	Suitcase Simulator
SDD	Solid-state Disk Drive
SIM	Similarity Assessment
SIO	Serial Input Output
SOW	Statement Of Work
SPF	Single Point Failure
SRD	Software Requirements Document
STS	Space Transportation System (Shuttle)
SW	Software

T

TBC	To Be Confirmed
TBD	To Be Defined
TBDCM	Training & Baseline Data Collection Model
TBDCMAR	TBDCM Acceptance Review
TBP	To Be Provided
TCP/IP	Transmission Control Protocol / Internet Protocol
TFT	Thin Film Transistor
TM	Telemetry
TRB	Test Review Board
TRR	Test Readiness Review
TRM	Training Model
TX	Transmission

U

UIP	Utility Interface Panel
UMA	Universal Mating Assembly
USB	Universal Serial Bus

1.3 DOCUMENTS

1.3.1 APPLICABLE DOCUMENTS

AD	Doc. Number	Issue / Date	Rev.	Title / Applicability
1	SSP 52000-IDD-ERP	D / 6.08.03		EXpedite the PRocessing of Experiments to Space Station (EXPRESS) Rack Payloads Interface Definition Document
2	NSTS/ISS 13830	C / 01.12.1996		Implementation Procedures for Payloads System Safety Requirements – For Payloads Using the STS & ISS.
3	JSC 26493	17.02.1995		Guidelines for the preparation of payload flight safety data packages and hazard reports.
4	SSP 50004	April 1994		Ground Support Equipment Design requirements
5	SSP-52000-PDS	March 1999	B	Payload Data Set Blank Book
6	SSP 52000-EIA-ERP	February 2001	A	Express Rack Integration Agreement blank book for Express Rack payload
7	GD-PL-CGS-001	3 / 17.03.99		Product Assurance & Rams Plan
8	SSP 52000 PAH ERP	November 1997		Payload Accommodation Handbook for EXPRESS Rack
9	SSP 50184	D / February 1996		Physical Media, Physical Signaling & link-level Protocol Specification for ensuring Interoperability of High Rate Data Link Stations on the International Space Program
10	SSP 52050	D / 08.06.01		S/W Interface Control Document for ISPR ***ONLY FOR HRDL, SECTION 3.4 ***
11	ECSS-E-40	A / April 1999	13	Software Engineering Standard
12	AMS02-CAT-ICD-R04	29.08.2003	04	AMS02 Command and Telemetry Interface Control document. Section AMS-ACOP Interfaces
13	SSP 52000-PVP-ERP	Sept. 18, 2002	D	Generic Payload Verification Plan EXpedite the PRocessing of Experiments to Space Station (EXPRESS) Rack Payloads
14	NSTS 1700.7B	Rev. B Change Packet 8 / 22.08.00		Safety Policy and Requirements for Payloads using the STS
15	NSTS 1700.7B Addendum	Rev. B Change Packet 1 / 01.09.00		Safety Policy and Requirements for Payloads using the International Space Station
16	SSP 52005	Dec. 10, 1998		Payload Flight equipment requirements and guidelines for safety critical structures
17	NSTS 18798B	Change Packet 7 10.00		Interpretation of NSTS Payload Safety Requirements
18	MSFC-HDBK-527	15.11.86	E	Materials selection list for space hardware systems Materials selection list data
19	GD-PL-CGS-002	1 / 12.02.99		CADM Plan
20	GD-PL-CGS-004	2 / 07.04.03		SW Product Assurance Plan
21	GD-PL-CGS-005	2 / 09.05.03		SW CADM Plan

Tab. 1-1 Applicable Documents

1.3.2 REFERENCE DOCUMENTS

Tab.

RD	Doc. Number	Issue / Date	Rev.	Title
1	GPQ-MAN-02	1		Commercial, Aviation and Military (CAM) Equipment Evaluation Guidelines for ISS Payloads Use
2	BSSC (96)2	1 / May 96		Guide to applying the ESA software engineering standards to small software projects
3	GPQ-MAN-01	2 / December 98		Documentation Standard for ESA Microgravity Projects
4	MS-ESA-RQ-108	1 / 28 Sept. 2000		Documentation Requirements For Small And Medium Sized MSM Projects
5	PSS-05			Software Engineering Standards
6	GPQ-010	1 / May 95	A	Product Assurance Requirements for ESA Microgravity Payload. Including CN 01.
7	GPQ-010-PSA-101	1		Safety and Material Requirements for ESA Microgravity Payloads
8	GPQ-010-PSA-102	1		Reliability and Maintainability for ESA Microgravity Facilities (ISSA). Including CN 01
9	ESA PSS-01-301	2 / April 1992		De-rating requirements applicable to electronic, electrical and electro-mechanical components for ESA space systems
10	ECSS-Q-60-11A	1 / 7 Sept. 2004		De-rating and End-of-life Parameter Drifts – EEE Components
11	ACP-RP-CGS-003	1 / Jan 05		ACOP Design Report

Tab. 1-2 Reference Documents

2. GENERAL DESCRIPTION

2.1 DESCRIPTION OF ACOP

ACOP is reliable special purpose computer to be launched to the International Space Station (ISS) to assist the operations of large science experiment projects. ACOP provides these services:

1. On-orbit recording mechanism for large volumes of data at high rates
2. Play back for downlink of the recorded data at high rates
3. A crew interface for complex experiments
4. General computing facilities
5. Alternate bi-directional commanding path via the HRDL interface

ACOP will initially support a state-of-the-art particle physics detector experiment Alpha Magnetic Spectrometer (AMS-02), which uses the unique environment of space to study the properties and origin of cosmic particles and nuclei including antimatter and dark matter, to study the actual origin of the universe and potentially to discover antimatter stars and galaxies.

After the AMS-02 experiment, ACOP will stay permanently in the US module as the only computer for large science experiment projects on the International Space Station for astronaut crew's use for recording and management of science data, monitoring and control of experiment, as well as improving the data communication between the earth and the space station.

In addition to the ACOP system there will be stowage bag sent to ISS that will contain additional hard drives that can be exchanged with the hard drives in ACOP. From time to time the astronauts will perform this exchange enabling ACOP to record all of AMS-02's data onto fresh hard drives. Once recorded, the data will not be overwritten; rather it will be transported to the ground as a permanent archive.

2.2 FUNCTION AND PURPOSE OF ACOP IN THE FRAME OF THE AMS-02 PROJECT

ACOP must meet the following requirements of the AMS-02 program:

1. Operate effectively in the ISS space environment.
2. Create an on-orbit recording of all AMS-02 science data on removable[1] media - explicitly hard drives, preferably SATA based.
3. Provide not less than 20 days of recording capacity without crew intervention (based on 2Mbit/second rates), longer would be better.
4. Provide not less than 120 days of recording media capacity within a single mid deck locker equivalent storage unit, longer would be better.
5. Recorded data is an archive. Disks must be provided for the entire 3+ year mission without overwriting (a total of ~23 TByte)[2].
6. For recording ACOP must support an orbital average data rate of not less then 4Mbit/second with bursts of up to 20 Mbit/second.
7. Provide a continuous operations display of ad hoc AMS-02 data for the ISS crew to monitor[3].

[1] Hot swap software not required but performing a hardware hot swap must not permanently damage the system

[2] The current contract ASI N. I/044/04/0 foresees the provision of 14 nominal hard drives plus 2 hard drives as spare parts. The individual hard disk capacity is 200 – 250 GB (TBC).

[3] The design presented in this report foresees the presence of a LCD monitor, not foreseen in the contract ASI N. I/044/04/0

8. Provide a continuous means for the ISS crew to issue ad hoc predefined commands without external equipment[4].
9. Provide, as needed, an exhaustive diagnostic, monitoring and operations environment via the EXPRESS laptop computer.
10. Support the playback of recorded data to ground systems at selectable data rates up to at least 20Mbits/second sustained while simultaneously recording at prescribed rates.
11. Support ACOP to AMS-02 commanding at selectable data rates up to at least 20Mbits/second sustained (No requirement for simultaneous recording or playback operations at higher rates.)
12. Support an alternate AMS-02 ground commanding and housekeeping report path via the HRDL interface.
13. CompactPCI based. Preferably 6U form factor.
14. Crew serviceable for upgrades and repairs - hardware and software.
15. Provide for upgrades and expansion to ACOP using COTS subsystems.
16. Provide support of ISS system upgrades (100bt MRDL follow on systems)[5].
17. ACOP will be housed in an EXPRESS Rack Locker.
18. The mass budget for ACOP is 35.5 kg for the EXPRESS Rack Locker and 35.5 kg for the soft stowage bag.
19. The power allocated to ACOP is 200 watts[6]

[4] The design presented in this report foresees the presence of a LCD monitor, not foreseen in the contract ASI N. I/044/04/0

[5] Not foreseen in the contract ASI N. I/044/04/0

[6] See Section 5.6 of RD11for the actual power budget

2.3 HARDWARE ARCHITECTURE

2.3.1 ELECTRICAL AND OPTICAL INTERFACES

The Fig.2-1shows the electricainterfaces of ACOP with the ISS and the AMS-02

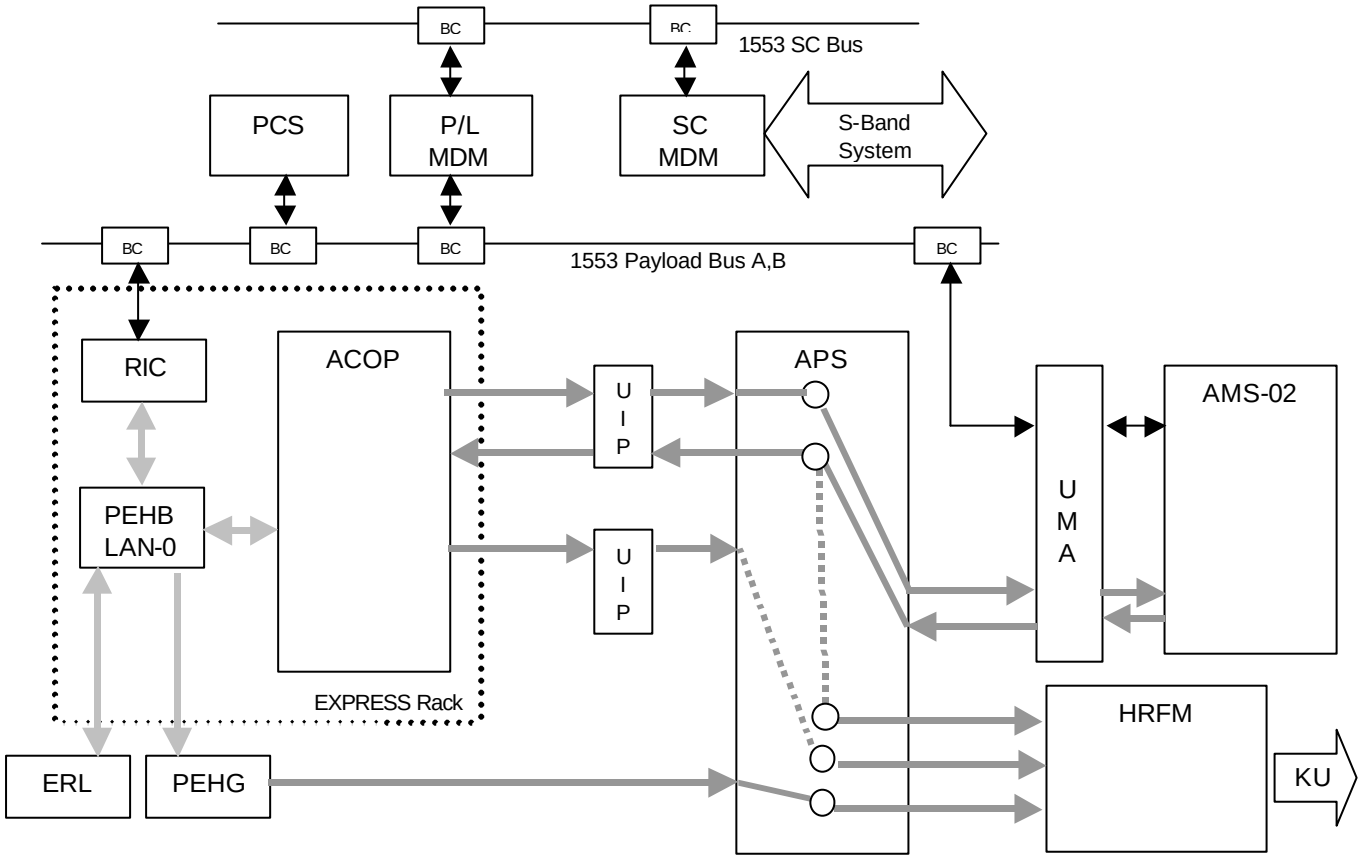

Fig.2-1 ACOP Relationship to ISS Avionics and AMS-02

2.3.2 ACOP HARDWARE ARCHITECTURE

The ACOP system is based on CompactPCI systems. It contains a single board computer and several custom developed interface boards, including HRDL fiber interface, Ethernet interfaces, two USB interface to upgrade the operating system and programs, and digital input-output and video interface. ACOP will also contain four exchangeable hard disks used to archive the data and the necessary interfaces. Other parts of ACOP are a flight qualified LCD screen and a simple push button interface, connected via peripheral cards.

In the main chassis and front panel are the electrical parts which include a set of digital computer hardware and software, the functional block diagram of electrical parts is shown in .

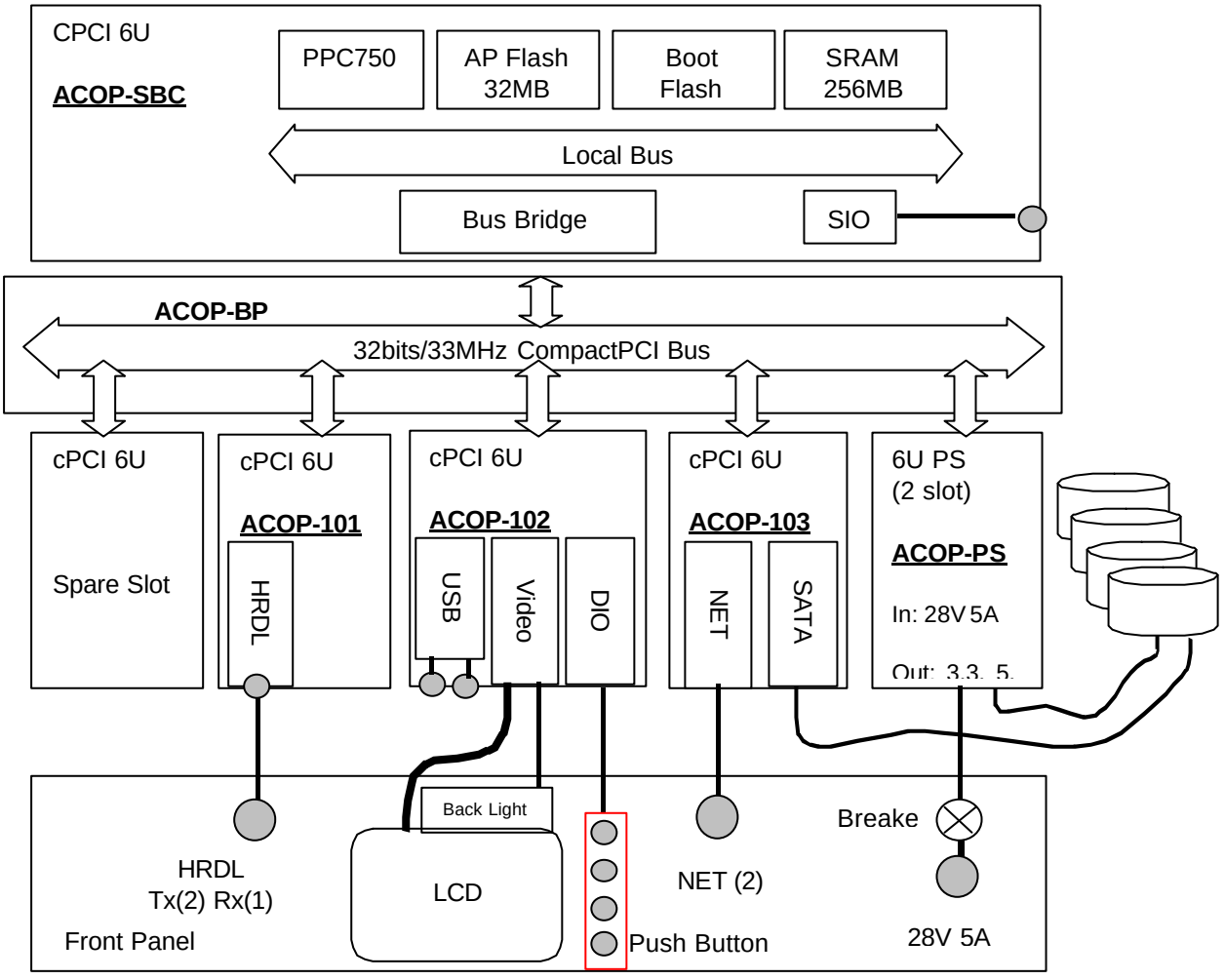

Fig. 2-2 ACOP Electrical Block Diagram

The ACOP chassis includes the following modules:

- ACOP-SBC: Single board computer based on the IBM PPC 750 which provides 400Mhz speed as well as standard CompactPCI bus interfaces and acts as CompactPCI system slot.
- ACOP-T101: Provides 2 fiber optic receive and 1 fiber optic transmit interface.
- ACOP-T102: Provides video output and USB interface.

- ACOP-T103: Provides 2 Ethernet ports and 4 SATA ports.
- ACOP-T104: spare for future expansion purpose
- ACOP-PS: Double height power supply.
- 4 hot swappable HDD (hard Disk Drive)

The ACOP front panel will be mounted with

- Four Momentary Press Buttons
- One Circuit Breaker On/Off Switch
- One HRDL Connector
- One Power Connector
- One MRDL Connector with 10/100 base Ethernet

During the engineering development stage, the I/O configuration will be tailored with PMC mezzanine modules and all modules integrate in an industry standard CompactPCI backplane. The design is scaleable and expandable, with a clear and built-in path for technology upgrades and insertion. A well-defined avionics Application Programming Architecture abstracts the application software from the underlying hardware, affording system evolution to ever-increasing performance standards, while effectively managing obsolescence. The Ethernet interface and USB interface can also supports software development and system maintenance during development.

2.4 ACOP SOFTWARE

ACOP-SW is the entire body of embedded software running on the ACOP hardware. ACOP-SW consists of three components:

- ACOP-SYS-SW providing low level functionality,
- ACOP-APP-SW providing the mission explicit application software functions on the ACOP hardware,
- ACOP-ERL-SW software developed by the ACOP project but which executes on the EXPRESS Rack Laptop.

The ACOP-SYS-SW consists of eCos, a open source embedded operating system and LINUX Operating System kernel (version 2.6). Drivers under LINUX OS for all the cPCI boards and the storage devices will be used.
The ACOP-APP-SW will be based on a cooperative multitasking system which moves messages among tasks. Tasks are used to provide: interfaces to external devices, functions (such as recording), data management (telemetry queue manager), and automation of functions (master control task).
The [RD3] contains a detailed description of the ACOP Software.

2.5 MECHANICAL DESIGN

ACOP is installed in one of the 8 locations for the Lockers of a EXPRESS Rack as shown in the following figure

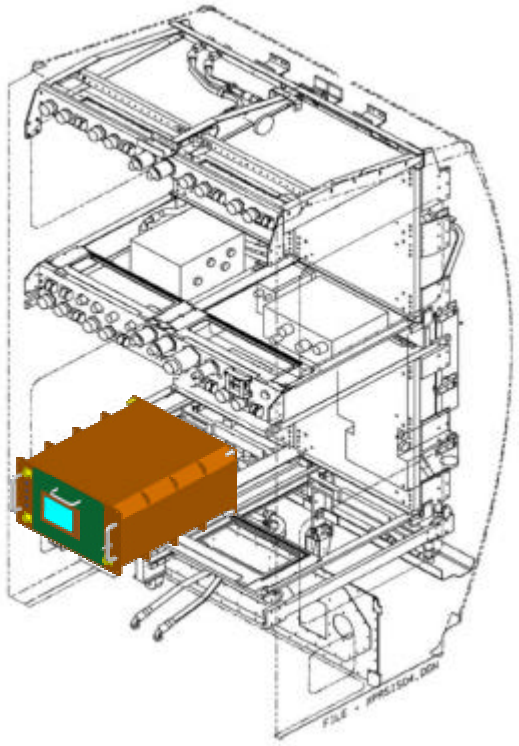

Fig.2-3 Location of ACOP inside a Express Rack

Mechanical structure of ACOP is mainly constructed by an outer structure (Locker) and an inner structure (Chassis). All the parts will be made of Aluminium alloy 7075T7351. Two different surface treatments are utilized:

- Clear Anodizing class1 according to Spec.MIL-A-8625

or

- Gold Alodine 1200 class 3 according to Spec.MIL-C-5541

2.5.1 LAY OUT OF CONNECTORS AND LCD (ON FRONT PANEL)

The Fig.2-4 shows the ACOP front panel: on the fixed part of the Front Panel three connectors (TBC) will be located for Power (28 Vdc) , Data (Ethernet) and High Rate Data Link Interface. Four buttons will be provided to allow control and monitoring of ACOP by the crew, the buttons will allow the crew to navigate into the menus displayed on the LCD. Also a Circuit Breaker will be installed. Two handles will also be installed to move, install and remove the ACOP. A LCD will be mounted (TBC) on a movable part of the front panel (LCD front panel), the movable part will be attached to the fixed front panel by means of a friction hinge placed on the bottom side of Fig.2-5 and held closed by a magnetic catch. The movable part show be able to be secured in the closed position by two ¼Turn Fastener/Locker placed on the corners of the top side. Indication by labels of the closed and open position will be provided.

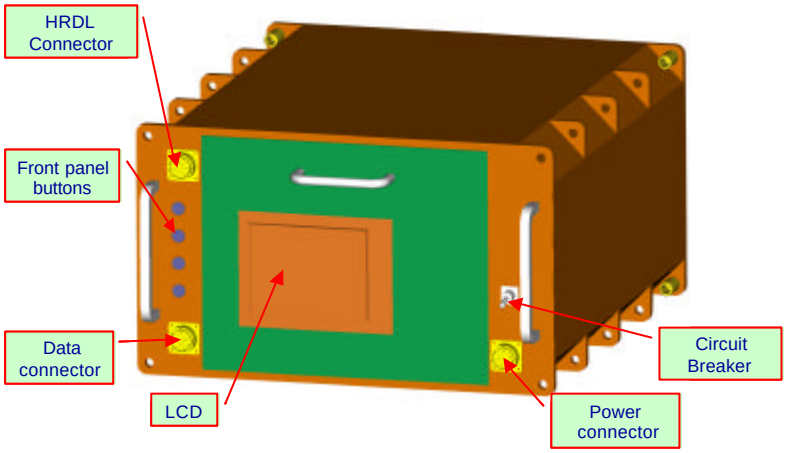

Fig.2-4 Front Panel Layout

2.5.2 INTERNAL BOARDS LAYOUT

Fig.2-5 shows the internal disposition of the ACOP boards as it will be seen by the crew when the LCD front panel is opened. The opening of the LCD front panel will be actuated by the crew after powering down the ACOP using the front panel switch. The upper part will be occupied by 4 HDDs that are mounted on four dedicated caddies. The caddies will be fixed to the chassis by means of card retainer (provided with lever arm to minimize the crew effort to replace them). The power and the data interface to the HDD is by means of a blind mate connector placed on the rear side of the HDD caddy , the usage of guiding pins to mate the connector placed on the rear backplane will be considered. The cPCI boards plus the Power board will be hosted in the low section of the chassis: also these boards will be fixed to the chassis by means of card retainer.

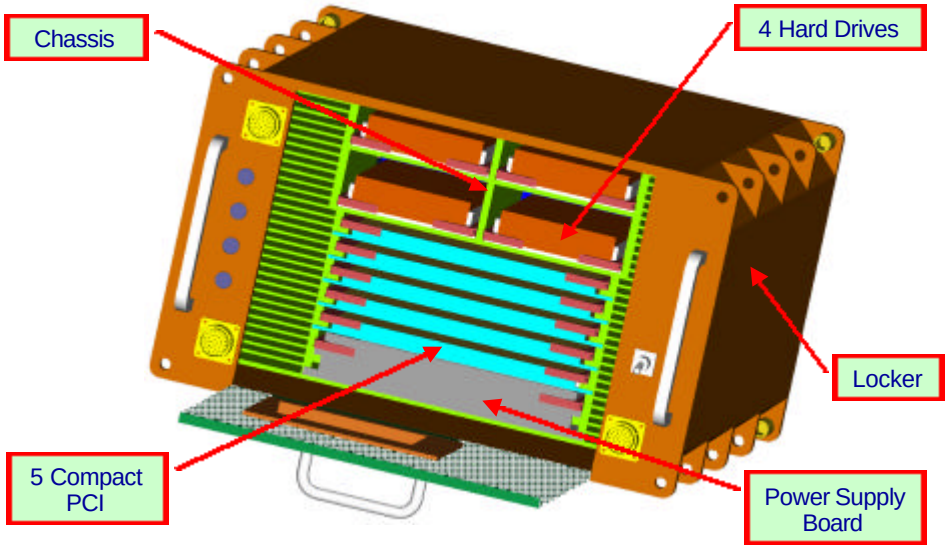

Fig.2-5 Mechanical and Electrical Main parts of ACOP

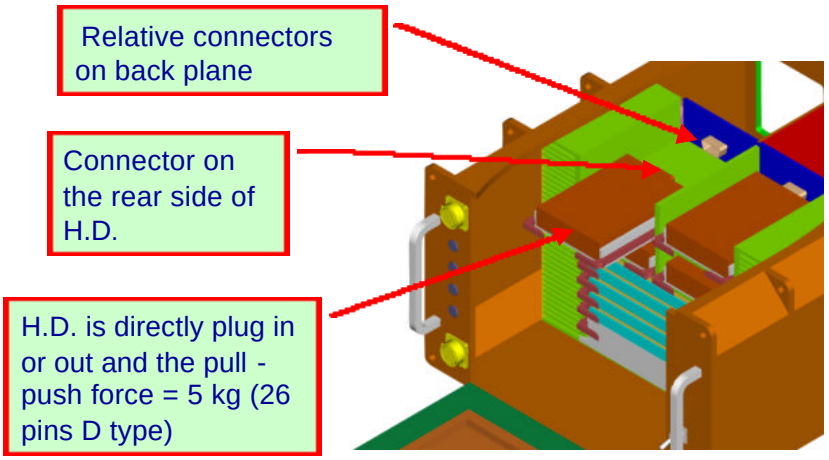

Fig.2-6 HDD location in ACOP

2.5.3 AIRFLOW INTERFACE

The ACOP will be cooled by airflow via Avionics Air Assembly (AAA) that provide fresh air blowing in and out through the holes on back plate of the Rack. The current baseline does not foresee to insert additional fans inside the ACOP locker to reinforce the airflow. Screen/grids will be mounted on the air inlet and outlet and designed in order to be easy to replace.

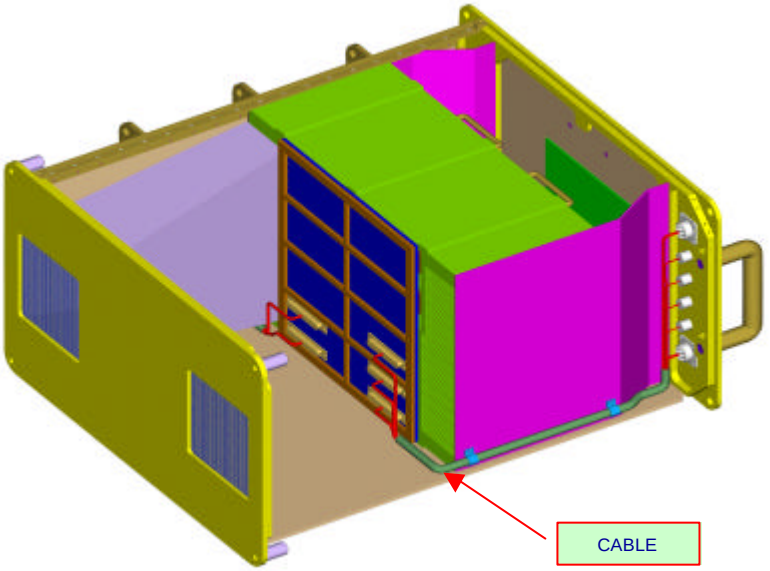

Fig.2-7 Rear side of ACOP

2.5.4 THERMAL DESIGN

Heat dissipation of hard disk drives and compact PCI boards will be conducted to the fins (wall) by conduction transfer. Airflow (via Avionics Air Assembly) will blow through the fins and remove the heat by forced convection (see Fig.2-8 and Fig.2-9). Also the LCD power will be removed by the AAA airflow.

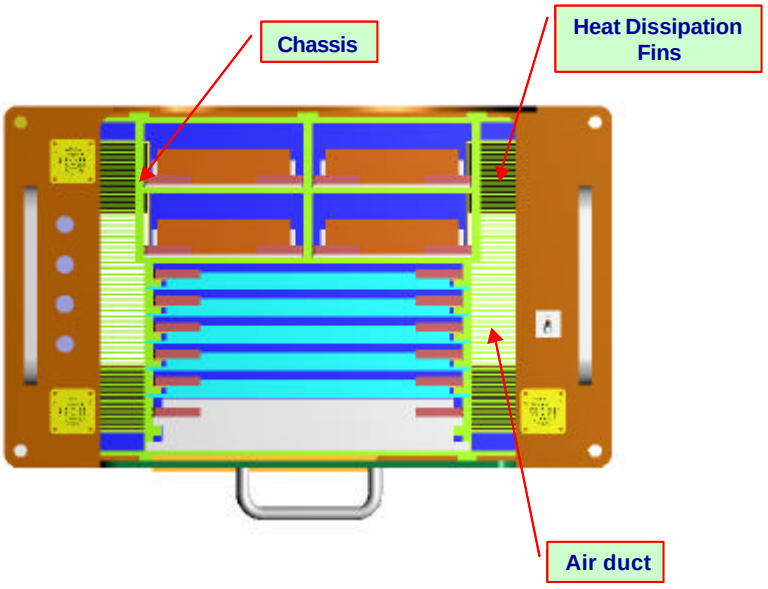

Fig.2-8 Thermal design (Front view)

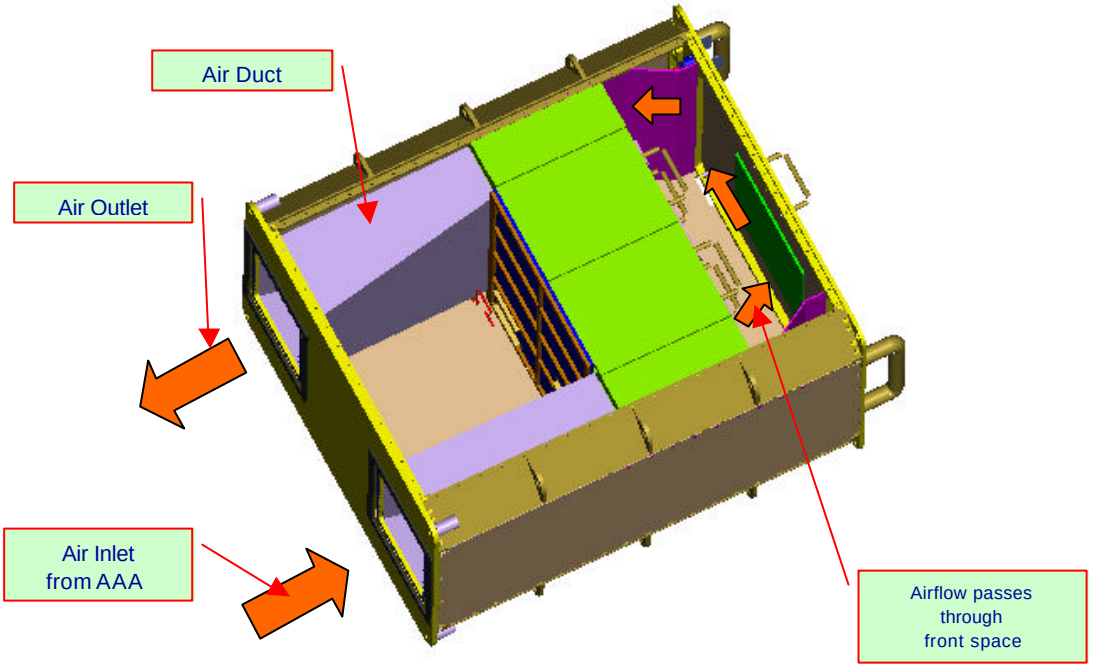

Fig.2-9 Cooling airflow

3. FLIGHT OPERATION PHASES

The Flight operation are here below listed. All the ACOP Flight Operations are safe in accordance with NSTS 182798B Interpretation Letter MA-00-038

3.1 LAUNCH PHASE

Nominally ACOP will be launched installed in a transportation rack within the MPLM (compatibility with other transportation modes as aft flight deck and ATV will be investigated if necessary). ACOP is not powered and no hard drives are installed during assent. Hard drives, and other spare parts, are carried in a soft side stowage bag.

3.2 FLIGHT PHASE

3.2.1 INSTALLATION OF ACOP INSIDE AN US-LAB ISPR

The ACOP will be installed into a US-LAB ISPR by the crew by securing the four captive bolts in the rear of ACOP to the EXPRES rack back plate. The launch locks on the front panel will be released and four hard drives installed.

3.2.2 EXTERNAL CABLE INSTALLATION

The crew has to install the external cables that connect ACOP to the ISS: Power cable (to be connected to Jx of ACOP front panel see RD4) , HRDL cable (to be connected to Jy of ACOP front panel see RD4) and Data cable (to be connected to Jz of ACOP front panel see RD4)

3.2.3 ACOP POWER ON

Other then brief (less then 8 hours periods) of ISS low power modes and during hard drive exchange ACOP will be powered on. The Power On phase consists of putting ACOP's front panel circuit breaker in the "on" and verifying on the display that the booting phase of ACOP has finished successfully and ACOP is in the cold start mode (see below). ACOP's operational mode can then be selected by interaction with the command interfaces (either by the crew or ground.)

3.2.4 ACOP POWER OFF

Nominally ACOP is informed that it is being powered down. When so instructed it enters the Active Idle mode. Once this condition has been verified ACOP can be switched off.

3.2.5 HARD DRIVE DISKS INSTALLATION AND EXCHANGE

The ISS crew will be in charge of installation and exchange of hard drives. The operation will be made with ACOP powered down.

The crew has to:

1. Retrieve the appropriate ACOP storage bag.
2. Power down ACOP per 3.2.4 above.

3. Open the LCD front panel by pulling the LCD front panel handle. The LCD font panel will remain in the open position thanks to a friction hinge.
4. HDDs already installed are removed and returned to the stowage bag.
5. Fresh HDDs will be inserted in the four slots present inside the ACOP and fixed with the card retainer: lever arm type card retainers will be used so no dedicated tools are required for this activity..
6. The crew will log the disk serial numbers of disks removed and installed.
7. Restore power and resume operation per 3.2.3 above.
8. Re-stow the ACOP stowage bag.

3.2.6 CREW INTERFACES

The crew is provided two interfaces to ACOP. A simple automatic teller machine (ATM) style of soft labeled buttons is provided via the front panel LCD. Support is provided for key monitoring and operations functions for both ACOP and AMS-02 via this interface. This interface includes ACOP front panel controls for the LCD for backlighting and contrast.

A second, more robust, interface is provided via the EXPRESS Rack Laptop (ERL) computer. It is anticipated that several graphical interfaces for both ACOP and AMS-02 will be developed for ERL.

3.2.7 OPERATIVE MODES

ACOP is primarily a ground operated system but can be crew commanded.

ACOP will have the following principal operating modes:

- Powered off
- Cold start
- Software upgrade (a special function of cold start)
- Warm start
- Active idle
- Active recording
- Active playback
- Active recording and playback

During any of the active modes ACOP can serve as a crew interface directing commands to AMS-02.

During any of the states other then powered off ACOP will accept ground commands.

The following shows the state diagram of the modes.

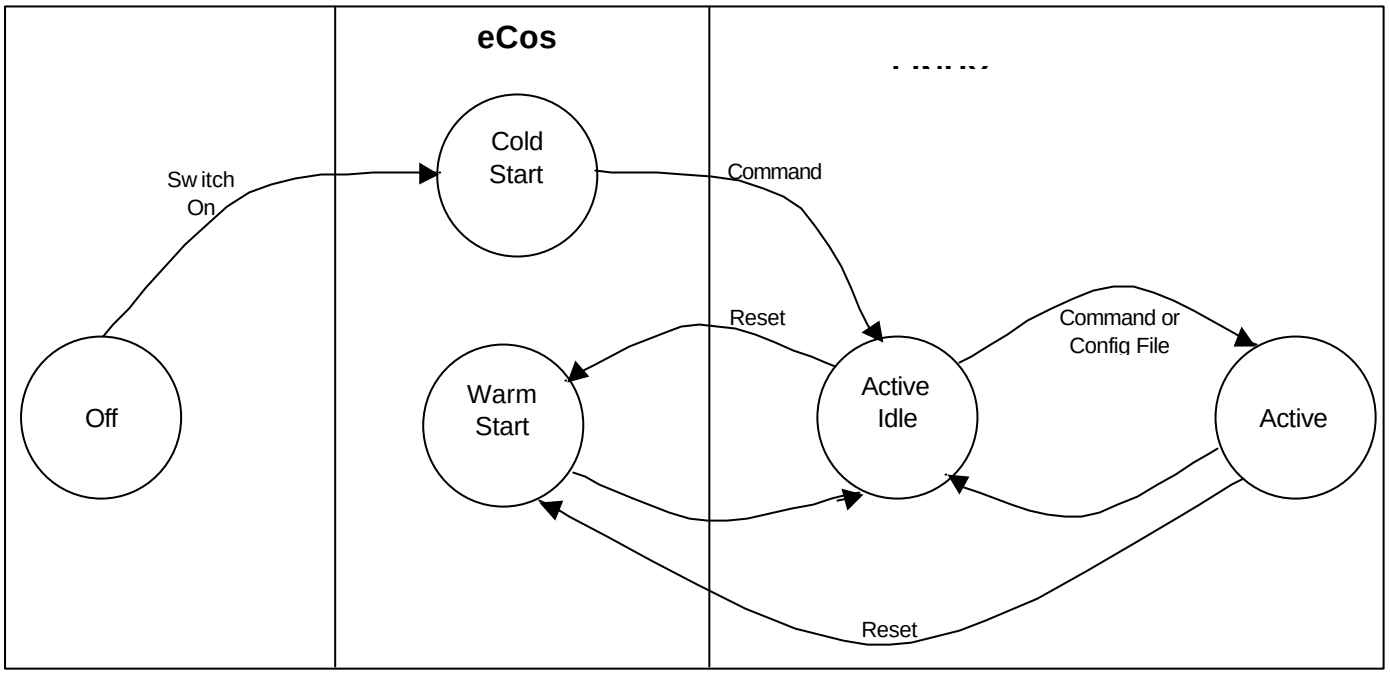

Fig.3-1 Operation Modes State Diagram

When ACOP enters the Cold Start state it can accept commands and requires a particular command to proceed to the active states. This command can originate from either the crew interfaces or the ground interface. If during the Cold Start State it is determined that a properly formatted USB key is inserted the crew is interrogated see if a software upgrade should be performed. A software upgrade consists of copying software and configuration files from the USB key to the ACOP software storage media (FLASH).

3.2.8 CPCI BOARDS AND POWER BOARD SUBSTITUTION

This activity must be considered as a non nominal activity to be performed in case or a failure on a board occurs or an upgrade of the HW is required. The activity will be performed with the ACOP powered down (the power switch must be put on “off” position) and according a specific plan that clearly will define the procedure steps. Also cable disconnection from the board front panel could be necessary.

3.2.9 SOFTWARE UPGRADE

The software upgrade will be performed by using a USB storage device inserted by the CREW in one of the two USB ports available on ACOP This infrequent activity is considered nominal The crew will power off ACOP, insert the USB key and power on ACOP. Activity will be monitored by the crew on the LCD display and the crew will be requested to verify the upgrade should occur. Following successful upgrade ACOP will be powered off and the USB key removed.

3.2.10 AIR FILTERS EXCHANGE/CLEANING

As determined necessary ACOP will be removed from the ISPR and the input screens and filters (if present) will be cleaned.

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3.3 RETURN TO GROUND

The current baseline is that ACOP will not be returned to the ground.